#### DOCUMENT RESUME

ED 316 088 HE 023 201

AUTHOR

Pizzo, Joseph F., Jr.

TITLE INSTITUTION A Lending Library of Physics Demonstrations.

American Association of State Colleges and

Universities, Washington, D.C.; Lamar Univ.,

Beaumont, Tex.

SPONS AGENCY

National Science Foundation, Washington, D.C.

PUB DATE

88

GRANT

MDR-8550611

NOTE

38p.; This report is one of a group gathered by the AASCU/ERIC Model Programs Inventory Project, funded by the Fund for the Improvement of Postsecondary Education to the American Association of State Colleges and Universities, in collaboration with the ERIC Clearinghouse on Higher Education. For related

documents, see HE 023 199-261.

PUB TYPE

Reports - Descriptive (141)

EDRS PRICE

MF01/PC02 Plus Postage.

DESCRIPTOPS

\*College School Cooperation; \*Demonstrations (Educational); Higher Education; High Schools; \*Instructional Improvement; \*Laboratory Procedures;

\*Instructional improvement; \*Laboratory Procedure

Models; Peer Teaching; \*Physics; Program Descriptions; Regional Cooperation; Science

Instruction; State Universities

IDENTIFIERS

\*AASCU ERIC Model Programs Inventory Project; \*Lamar

University TX; Lending Library of Physics

**Demonstrations** 

#### ABSTRACT

Twenty-three self-contained single concept physics demonstration packages were designed and constructed at Lamar University (Texas). Each package was available for loan to pre-college science instructors in southeastern Texas in the spring and summer of 1987. During the spring, three high school physics teachers used the demonstrations and provided evaluations that resulted in minor modifications in them. In the fall, five schools participated. Follow-up visits to the teachers who used the demonstrations revealed that some teachers needed both extensive help with the experiments and a broader conceptual base. The project continues by Lamar University with the addition of demonstrations to the lending library and increased school participation. A primary project focus is the establishment of communication with pre-college teachers in need of help but reluctant to seek it. A sheet for each of the demonstration packages provides a statement of the concepts illustrated, a description of the package, and suggested activites. (MSE)

Reproductions supplied by EDRS are the best that can be made

\* from the original document.

#### A LENDING LIBRARY OF PHYSICS DEMONSTRATIONS

Joseph F. Pizzo, Jr. Principal Investigator

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

This document has been reproduced as received from the person or organization organization organization.

Minor changes have been made to improve reproduction quality

 Points of view or opinions stated in this document do not necessarily represent official OERI position or policy "PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Joseph F. Pizzo, Jr.

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ERIC Full Tox t Provided by ERIC

**BEST COPY AVAILABLE** 

#### AASCU/ERIC Model Programs Inventory Project

The AASCU/ERIC Model Programs Inventory is a two-year project seeking to establish and test a model system for collecting and disseminating information on model programs at AASCU-member institutions—375 of the public four-year colleges and universities in the United States.

The four objectives of the project are:

- o To increase the information on model programs available to all institutions through the ERIC system
- o To encourage the use of the ERIC system by AASCU institutions
- o To improve AASCU's ability to know about, and share information on, activities at member institutions, and
- o To test a model for collaboration with ERIC that other national organizations might adopt.

The AASCU/ERIC Model Programs Inventory Project is funded with a grant from the Fund for the Improvement of Postsecondary Education to the American Association of State Colleges and Universities, in collaboration with the ERIC Clearinghouse on Higher Education at The George Washington University.

**BEST COPY AVAILABLE** 



#### Technical Description of Project and Results

In accordance with the proposed goals of this project, twenty three physics demonstration packages have been designed, constructed and assembled into a "lending library". This library is housed and maintained in the physics building at Lamar University. Each package is complete in every detail and ready to use with no additional equipment needed. A list of the demonstrations available, a description of each demonstration package, and a copy of the letter sent to the pre-college physics teachers and some selected physical science teachers in the South-east Texas area follows.



NATIONAL SCIENCE FOUNDATION Washington, D.C. 20550	FINAL PROJECT REPORT  NSF FORM 86A	
I LEASE RE	AD INSTRUCTIONS ON REVERSE BEFORE COMPLI	TING
PAF	AT I—PROJECT IDENTIFICATION INFORMATION	
t. Institution and Address Lamar University	2. NSF Program Materials Developmen	3. NSF Award Number MDR - 8550611
P.O. Box 10046 L.U. Sta. Beaumont, TX. 77710	4. Award Period From 2/1/86 To 4/30/88	5. Cumulative Award Amount \$13,866.

6. Project Title

A "Lending Library" of Physics Demonstrations

PART II—SUMMARY OF COMPLETED PROJECT (FOR PUBLIC USE)

During the period of the grant, the principal investigator designed and constructed twenty three self-contained, single concept physics demonstration packages. Each package was available to be checked out by pre-college science teachers in Southeast Texas. Workshops on the use of the demonstrations were provided in the Spring and Summer of 1987.

During the Spring of 1987, the demonstrations were used by three high school physics teachers with whom the principal investigator is well acquainted. These teachers provided evaluations of the program which led to minor modifications.

During the Fall 1987 semester, five schools participated. Packages were delivered by either the principal investigator or a student assistant and then picked up in one week.

The principal investigator made follow up visits to all participating teachers. As a result of these visits, he discovered some teachers who needed intensive help not only with the demonstration packages, but a broader base of concepts.

The project will be continued by Lamar University. Demonstrations will be added to the library. Participation will be increased. A main focus of the project will be the establishment of communication with pre-college teachers in need of help, but reluctant to seek it.

PART III—TECHNICAL IN  ITEM (Check appropriate blocks)	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (~)	Approx. Date
a. Abstracts of Theses	X				
b. Publication Citations	X				
c. Data on Scientific Collaborators	X				
d. Information on inventions	Х				
e. Technical Description of Project and Results		Х			
(. Other (specify) Dissemination of Results		X			
. Principal Investigator/Project Director Name (Typed)	3. Principal investigator/Project Director Signature		4. Date		
Joseph F. Pizzo, Jr.	; 5/5/8			5/5/88	

F Form 98A(1-87) Superpedes All Previous Editions



August 27, 1987

Dear Physics Educator,

This is an invitation to make use of the Lamar University "Lending Library of Physics Demonstrations". I have enclosed a list of the demonstrations available, along with a packet which includes a brief description of each demonstration.

If you see anything that you can use in your physics or physical science classes, please call and have a demonstration package sent out to you. Each package is complete down to the last detail - you do not have to worry about searching for any auxiliary equipment. There is absolutely no charge for this service. It is made possible through a grant from the National Science Foundation. The demonstration packages will be delivered and picked up each Friday afternoon starting September 4. There is no charge for this service either. If this is not a convenient time for you to receive the demonstrations, you can make arrangements to pick them up at the Lamar University Physics Building at your convenience.

Each demonstration package may be kept for one week (we suggest you try out most of the demonstrations yourself before you use them in class). We will not limit the number of packages (within reason) that may be checked out at one time unless the demand becomes too great.

I have already made duplicate copies of some packages, for which I anticipate heavy demand, and will continue to do so as conditions dictate. If you want to illustrate a concept for which I have no demonstration, let me know. I want to add to the holdings of the "Library".

As you use these demonstrations, you may discover that many are so simple that you could duplicate them yourself and start your own collection. I hope so! Let me know if I can ever help you locate anything you need.



Finally, feel free to call on me for advice or suggestions at anytime. I look forward to working with you in the interest of Physics Education in our Community.

Your colleague,

Joe Pizzo

Professor of Physics

#### Usage

The preceding letter, package list, and demonstration descriptions were sent to twenty two pre-college teachers, on August 27, 1987. Five teachers chose to participate during the Fall, 1987 semester. It is the opinion of the principal investigator that participation can and will be increased by follow up letters and personal contact.

A list of participating schools and package

A list of participating schools and package distribution follows on the next page. The location of the schools and their approximate distance from Lamar is given below.

<u>School</u>	City	Dist. from Lamar
Stephen F.Austin High School (SFA)	Port Arthur	10 miles
Westbrook High School	Beaumont	10 miles
Port Neches-Groves High School (PNG)	Port Neches	15 miles
High Island High School	High Island	40 miles
Lumberton Intermediate School	Lumberton	20 miles

ستاسع موسال والبوا والبوار والبارد استون والماد سنيه المدد عليات بالدود وجارت والمدد والبارد و	9/11-9/18	9/18-9/25	9/25-10/2	
Ambient Noise Resonators			po . 2000, Salas sano, apr. mapa dina basis kelan Salas span Salas sano dina alian silan sano	
Amatamia as Cound			y ng nyafa in hay milan dawa dinisah dawan kadin hadin didah didah dawin dawin dalah dadah sakad dapah d	
Artificial Sunset				
Bed of Nails		nen dien gege genet beng genet reges pann belok gege, term denke dien fiche	pada dada seba anna aman bang pina bala anda bana pilan finah maka Mada basa sebir.	
Center of Mass	SFA *		منتسبة الكوام مجينية بالمقد الكرامة والنوام الركامة المؤام المؤام المؤام المؤام المؤام المؤام المؤام	
Curved Space				
Diffraction				
Gumby Ride			SFA	
Interference				
Law Topporature Effects			, many matrix spaces strong pumps, many strong strong spaces strong actions and strong actions are	
Mudslinger 1		Westbroo		
Maradan 1 dan mana - O		PNG		
Name de marine Cravity		Westbrook		
Name Transfer I Pof France			يار تقييد ( د ) وتوليد علياء. يجالب شاسة عنظة تقالد والجامة للجامة الدواء إليكم تبدأ ألمانية	
Polarization: Scattering			ga Barry Mahay Makai Manai Barry Sandhi Mahay Segang diniki yanin sirkin makin Angar Mahay Mahay Ma	
Polarized Light	and drop pasts grade many human state, and parties are grade states are seen and the second states are seen as		والمراجعة والمدار والم	
Detation Platform		SFA	عيين والمار والمار ومارة المارة المارة والمارة والمارة والمارة والمارة والمارة والمارة والمارة المارة المارة	
			my typin dulu, mine salas 1600,000 gipto Guere (tria) pyrle yran dank pamy (filler Guer). B	
			ular (Mala Pagas pietro Joses Andro 1888). Spent Spunt Stein, applik Spunt Anne Allans, göder Anner A	
Company			يستعد منطق يعتم يعتب ومناح ومناء ومناء ومناء ومناء ومناء يعتب ومناء ومناء ومناء ومناء ومناء ومناء ومناء	
Direction Union on a Pone			كمنا فيت كالمد ويجد فيجد بيداء ويدن ديدا ويدن ويدن ويدن ويدن ويدن ويدن ويدن ويدن	
ablecloth "Trick" 1		Westbro	5k	
Tablaclath "Trick" 2	والمراجع ومردو ومارو المارات وينموا المردو المردو والمردو والمردو والمردو والمردو والمردو والمردو والمردو	PNG **	ganing darigit States Priests States	
Vibrating Membrane	ة الألب النامل ووقود بينين الإنجال والله والدر النامل بعدد <sub>الط</sub> ول ، تحتل <sub>ا</sub> لديد	والمراق المراق والمراق		
Weight in Newtons	SPA	PN	G	



And their halfs they show they was a print their	10/2-10/9	10/9-10/16	10/16-10/23
Ambient Noise Resonators		and the state which the state with the state when the state of the sta	
Analysis of Sound			mark kann pant tang salah dari bari bati ban bang birih gaya baga salah gari bari Ban salah bari bari bari bari bari bari bari bari
Artificial Sunset			
Bed of Nails		PNG	والتحق عيبون المجموع بمتناور ولينان لا يعيد وتسعيد المتناب ويتناور المتناور موقعة شرحية الانتهاء والمتناور الم المتناور المتناور المتناور المتناور المتناور المتناور وتعيد وتجديد والمتناور وتعتاور المتناور المتناور وتعتاو
Center of Mass		PNG	Marie Calle Jack Capill Capil A Alle Carrie (1932 1932 1932 1934 1934 1935 1935 1935 1935 1935 1935 1935 1935
Curved Space			
Diffraction			مستوان وسيد هلواء وليام الأنفاء وليك مستوار بعدي يشديه مياني ولاياد صبيل وأبان ويباد ويباد ويبود كتب 
Gumby Ride		PNG	
Interference		Mari alam pand Mayr pilani, Masa daga rarah, alah pilani, sabra gilan kisina mada gaya s Mari gilan ayak May dalam pilan kana darah dalam atau dapar dapar gaya, gipil masa	
Low Temperature Effects		Mile Galle, gold Male Calle, grape laws, Greek Male, gales above Part gapes, gold Jame i	
Mudslinger 1			
Mudslinger 2		aasa birto agand diges, pemer petto agan taren ature spera adang adan paga angan beasa j Bara andan mada tara, matus anan diges com, talah sebat aspen biber agang beas ayan	
Newtonian Gravity		SFA	
Non-Inertial Ref. Frame		Mad dilike spelik digari pilake sehiri yapa, spiras binas pajas gapas pana pagai paya payar g Tangan dilike sehiri dilike pilake sehiri yapa dilike masa pana pagara dilah pilake paga badar dilike sehiri basar dilike pilake sehiri yapa badar dilike sehiri basar dilike pilake paga badar dilike sehiri basar dilike pilake paga badar dilike sehiri basar dilike pilake pilake sehiri basar dilike sehiri batar dilike sehiri basar dilike sehiri basar dilike sehiri basar d	SFA *
Polarization: Scattering		mills maker allaste district pusher south diesem winter deren Appen alleh ausgegebe geden bedet b	مناه دهنم المقابل بينهم المقابل والمقابل والمقابل والمقابل والمقابل المقابل المقابل المقابل المقابل المقابل المقابل
Polarized Light	والمرابع	lake dalah gara daga dalah pendi daga daga Pilap daga juga juga daga daga pada pada pada pada gara s Man pada ujuga bara bada pada daga daga daga daga dara daga pada daga pada daga pada daga bara daga daga daga	Mini Andr Agad Speed Allow Asses Speed States States Asses Asses Andre Asses Asses Asses Asses Asses Asses Ass
Rotating Platform		Mila pada asati Popi katiy pada Nijil Romi Mila godi goti gala asa, asaa dan Anna y 	
Scattering		ning spall allern dalle, paller, palen 1904 daller 1906 place delle 1906 appe, dueld figur, f 	
Singing Sewer Pipes		name mener daga mang pina star, angg angg paga balah bibi, gung angg bibi.  Tanggan balah bibi, gung angg Afrik Janus maga dibin kana B <sup>angg</sup> anan anggan pana bang b	
Spectra		taja aga- jaja-d ding magin. Afab jama magun dilan dana Beril anda gaga- pama jang f Magin dana dilang dilang dilang dilang dilang dilang pelanggan dana dilang mga jang dana pengan jang pengan dana pengan pengan dana pengan pengan dana pengan pengan dana pengan pen	
Standing Waves on a Rope			
Tablecloth "Trick" 1		diti gami garif finga garif gami gami kaga dibbo satu garif gadin dibu bang gaga panir a	•
Tablecloth "Trick" 2		ه جندی دهمین دارد کاردن میشد داشت بایدن پرستان داشت و بایدن بدین داشت و بایدن درد از در در در در در در در در در	
Vibratin, Membrane	their Parist Depts rated Triffic dilan paner spars; were optic state disput th	riil anns dâir 1986 puirs grès dinn, haat arer dans formt area a-pa a-pan frêb a	die offin een diese film dere ande die, deus gest aus, deus anne uiter ause das

	10/23-10/30	10/30-11/6	11/6-11/13
Ambient Noise Resonators	andan anjan ruga pama u jami angu migug alahi, ganta anaka diang palah u	garar manga anaga, samba Anggar Panaga Anara, yangki gapahi Anbiba, ulagai Anara, yangan dayapa d	phone first began then soon soons . As soons whist value during their value made first being begin
Analysis of Sound	direk tilperi velar i krein musek leptus Plany, afrika gayer danne fillika upitu di	affir diese their anglik hann fillen della ayata amatik hand gapus lasan pipa diana	ماجي عليه فيها الحول وماها فيلما ويوبر فيها ويؤاه فيها فهلن الأمل الأمان المراه المراه المراه المراه المراه ال
Artificial Sunset		arir Silay Birde abert Milli Million Mily pater <sub>space</sub> antity gapes down gapes drawn of	
Bed of Nails	High Island		rring ment arver f <sup>ar</sup> et mang mang in, ver man <sub>e</sub> , apply gopt begen, colle gaver (gave bings palmag 
Center of Mass	gente soure fluire gare cours away tampe Affel goods soude titles within a	anni maad Miling dadi minig digaa diink aada aada ahda diben aada pirin iyaac i Milin aada diinka di	
Curved Space	PNG *	term union princ galan balan dingan dinny gapan pagan army asiala galan asial bisan i	يستان ويولو وساجه الناس الناسة وبداء وميان والثان لينواه الانصف والناس وبالنان ولايان فيتواه أدبوا طبوق
Diffraction	amak kirat dinan dipin kurat dinah dinah dinah dinah sirak dinan dinah pidar (	gager '-nin dang gala' njuju kawa dang prima Prima dalah Sajer pilabi gager balah Malay '-nin dang pilabi njuju maga kang dalah Sajera bana dalah pilabi bilabi	naka danah bagan <sub>mal</sub> a bagan a <sup>mba</sup> r entak menah danah danah gabir apam bakan banah gada sempa
Gumby Ride		Westbrok	خويدة فينهم مطلب يعقدة فينهم حسنت بسامة خفوت خفوت وكديا وينحان كنيفة فيزين فسنده بيبدة فنعت
Interference		gart maga anga gatan keper maga kana ganta upata saka yanga annap pera banda.	adag Brips mang Brigs pertis terbis danan eras, datan e am terin, dara, tem e qualit t upo fland
Low Temperature Effects		appel dama maka appiri saine Poles Silve appel bendri Aribo Space Golde dama bibar: 	
Mudslinger 1		andri Pritter States gath's Gazer Andres States groves, popula Gazet States States (States agent States).  Lander spilate States gath's States Gazet States States States States States (States States States) as you can't	
Mudslinger 2	arting gamble proper Minney (Argue andré il did attent gamble anno attent danny (	مناه خوان بيان المناه	pinka bang pagai Mililip bilana Palini banda Angara papai papai tingay antina pinka pagai diang atang
Newtonian Gravity	PNG	Hightsland	
Non-Inertial Ref. Frame	PNG	His h Island	there there there where the transport paint paint the Table and the tree the tree the tree the tree the tree the tree tre
Polarization: Scattering	gapina dagana damang Studio sepirati Studio damang danlay apalan Sandri Studio damina.	and any this year size they they gay year that any put year, or a	ports from the of the permit arms many proper to the population permit ports and their date.
Polarized Light			
Rotating Platform	PNG	igant digits diada jatifus mana darent treba yang marit dista didita diada mana daren Managan digit di	
Scattering			NYPO JOHLA 1990, gallet alema Profe galay samal 1880 ppd., milli Nylo' feam thing johla sent NYPO JOHLA 1990, galah tama danga gilah samal alema galah samal senta feam dalah galah samal samal dalah galah
Singing Sewer Pipes			
Spectra			
Standing Waves on a Rope			print dight dight from dring open pent pent state and a good dhink pent flow good good good good good good good go
Tablecloth "Trick" 1			
Tablecloth "Trick" 2		هنده سنید به بازد و برسم ۱۹۵۰ و برسم ۱۹۵۰ هنده سنده سنده ادامل بسته بداری افسی	
Vibrating Membrane	يسمد ودوات ويدوان ويدوان ويدوان والمدون والمدون والمدون والمدون والمدون والمدون	والمراقبة	plate span plate Poly, entry helft filter erler geta gave man, dans geta gett man geta
Weight in Newtons	HighIsland		



THE REAL PROPERTY AND ADDRESS OF THE PROPERTY ADDRESS OF	11/13-11/20	11/20-11/25	11/25-12/4
Ambient Noise Resonators	_		
Analysis of Sound	THE THE PARTY NAMED AND PARTY		at Princ plate Mage etter princ plate dage gave, etter blade path david beland selley galley alleka annen Berny g alle spate entre princ barr Mage spate spate path bayes spate byle british dages pate
Artificial Sunset			
Bed of Nails		·	a brief them, gards down starts dark petrol trapp arms totals dark dark many many many
Center of Mass		gener destrict began beleen daate diese stelen daare daare daare daare daare daare daare beleen beleen beleen Daren noord: drake daare beleen daare	y differ parish basey differs and marrier disque states garden from plants sparse garden bases
Curved Space			Weethrook
Diffraction		And the last the same the same through the same that the s	
Gumby Ride	,	Calle Calle Princ State Calle page (STA) Mills Marie Calle State State State Calle page page  State Calle State State State Calle State St	
Interference			من منظم بالله الأمام الأمام الله الله الله الله الله الله الله ا
Low Temperature Effects			
Mudslinger 1		the new was not over two two test two ages and age, and and an	
Mudslinger 2			ng tilah papa dapa dang akan dapa dapa pang papa paga paga paga paga paga p
Newtonian Gravity	Mare (Miles proces annote from merca , apar finance tamon annote tapong pungg pungg 	No. T. I	an dilah, gain dijan dilah atawa katal dilah dijan peter dilam dang priba talah masa, 1998. Talah dilah di
Non-Inertial Ref. Frame	سمية والمنافع والمناف		t dibus griffi filoso disus pilot agaid filoso picco, pilot tipas picto filoso della stopa eripa
Polarization: Scattering	,	ann ann aire ann ann an agus agus ann ann agus agus agus ann ann ann ann	المقاول كالمام كالمام المناول المناول المناول المناول المناول المناول المناول كالمام المناول ا
Polarized Light	يست جهذب فسهي بيسفة بهمقه بهمين يسهم سائلت خاذفة وكهن وليقط فجهد	Itigh Island	؟ كالله غياسًا كينهن بلطن يشكن للبناء اللبناء وكول ماجاة عليه يمين يسبب كالله فالمن
Rotating Platform	gay, man, difer diple softe again felles diago desse from from other annu	there again, again that also, back also, their they have being gains with their area, also with their	, piller ugen damig fielige deuts feiler fliest grades mitter diefen eller: "deut damis damis damis
Scattering		man anger tiper were dark being toper besse brees being tiber tiber tiber days and their besse besse tiber t	
Singing Sewer Pipes	هي جوهو پيمي پويمية باشك سيود مڪثرة جيسي استيث فائلنڌ اجيس ميشدن	هيهم. شهوي خاطب ميست جنعل جماعة الكناس كنتما قبطت خاطب الكنان خاطبة خلطة خلطة الكنان ميس المن	a device makes from mind there has many years many proper makes around make
Spectra	mer allin, gilder byrer (drigt divide apone grapp dygigt starts tiller divide, datilig	ands then then does the gape them seem years gard that, years gand upon man.	y timbo ayon Alays dilika autin ladin Saga privir ayin, Youn dayon prilip basa dilak Shat
Standing Waves on a Rope			
Tablecloth "Trick" 1	anta pama gana angun anny asia, 400° , 1150,0 9050, 2050 asia Anta Anta asia	يست يسيد الشيد المناه المؤمو المناه يستان بمثلة يستن يمين المناه المناه المناه المناه المناه	i agent flame, transis, quapit daman, datus, galler galler galler daman dress datus transis datus datus datus
Tablecloth "Trick" 2	بندية الله الدول الله الدول الله الله الله الله الله الله الله ال	entre eller fille distri sion, man d'est mète siere signé litre elles d'elle aux siere	وهم وهمه معمور وهي منهم ومدو المهم ومثلة علينة المهم المهم ومثلة ومنها ومنها ومنها ومنها
Vibrating Membrane	Pri triby come mane them pends them anno green from design steps pends	يستان والمراد مانية والمراد المراد	بدعه منهم منهن منهل بشهل بهري منهم فهم بمنه بهم المهم المهم المهم المهم المهم المهم المهم والمهم والم

\* mak visit myself



	12/4-12/11	1/4/88
Ambient Noise Resonators		
Analysis of Sound		
Artificial Sunset		Limberton*
Bed of Nails		
Center of Mass		
Curved Space		
Diffraction		
Gumby Ride		
Inter/erence		
Low Temperature Effects		
Mudslinger 1		
Mudslinger 2		
Newtonian Gravity		
Non-Inertial Ref. Frame		the office dated player depths and contact ands, again dated, from player, com-
Polarization: Scatterin	g	20
Polarized Light		di Milita dalah dalah dalah dalah dalah dalah pesah pesah dalah da
Rotating Platform		
Scattering		
Singing Sewer Pipes	delign contra de seum despe aum peper mine prope quem gant perso mora direy desse per	
Spectra	Office rights deliver densor plans common grants	
Standing Waves on a Rope		
Tablecloth "Trick" 1	The same are the same page with read and page pick which reply after the	try jeloka natilin flator upitim dality upitim grafu grafu papin parin dalah nasali dalah
Tablecloth "Trick" 2		ne jane didd han glan dlai mae dda cale agus ann ann bha bai
Vibrating Membrane	after Arch east erin Mile was pass about this was the start was the same and the same and the same and the same	der Sintle annie Sente Geries Sinte geleit adeur Anlijo Julies Sintel Gerie Anlijo deur



#### Significance of the Project

While the number of participants was small, it is felt that the results are significant and the project is one that could be emulated by many colleges and universities.

The original goal of the project was to supply precollege teachers with ready to use physics demonstrations to enhance the traditional delivery of science education by lecture and laboratory. That purpose is certainly served. In fact two experienced educators who have used the packages have copied many of the demonstrations and are now building their own library.

However, the main significance of the project is one that was not fully anticipated. Three pre-college teachers of physics have used the demonstration packages as an "excuse" to open a dialogue with the principal investigator and reveal their lack of preparation in physics. (The best background among the three is two semesters of algebra based physics.) Why the Boards of Education should allow such situations to exist is not of immediate concern to the principal investigator. The main objective at this time is to offer every possible assistance in addition to the demonstration packages. The principal investigator has even been asked by two teachers to take over one of their classes while they observed.

The significant point is that without the demonstration packages as a focus, it would not have been easy for these teachers to identify themselves and take the principal investigator into their confidence. While either delivering the packages himself or making follow up visits, the college teacher has the opportunity to interact with the pre-college teacher in a way that is neither intimidating nor patronizing.

It is the opinion of this investigator that the availability of pre packaged demonstrations offers an excellent opportunity to open lines of communication with the pre-college teachers in the area.



#### Dissemination of Results

In order to share the results of this project with as many educators as possible, the principal investigator has made several presentations to science teachers at both the national and regional levels:

- 1. " Demonstrations to Go ", a workshop presented to the Science Teacher Association of Texas regional conference, in Beaumont, Texas, April 25, 1987.
- 2. " A Lending Library of Physics Demonstrations A Pilot Project ", a presentation to the American Association of Physics Teachers national meeting in Bozeman Montana, June 17, 1987.
- 3. " A Lending Library of Physics Demonstrations ", a presentation to the Conference on the Advancement of Science Teaching in San Antonio, Texas, November 21, 1987.
- 4. " Demos to Go ", an invited paper to be presented to the national meeting of the American Association of Physics Teachers in Ithica, New York, June, 1988.
- 5. The principal investigator has been invited by the Region XIII Education Service Center to present a workshop for the Austin area Physics teachers. Date of presentation will be June 30, 1988.



#### **Future Directions**

The physics department at Lamar University will continue the support of the project by supplying equipment, student assistance and transportation.

The principal investigator plans to extend the project in the following ways:

- 1. After using the demonstrations from Lamar's library, teachers will be offered encouragement and assistance in constructing their own library of demonstrations.
- 2. Ideas for new demonstrations will be solicited from pre-college teachers and added to the Lamar library.
- 3. Demonstrations will be cross referenced by topic.
- 4. Video tapes will be made, showing the principal investigator setting up and using each demonstration package. Upon request, a copy of the tape will be available with the demonstration package.
- 5. The principal investigator will continue to use the "carrot" of the demonstration packages to seek out and work with those teachers whose physics background is inadequate.



# AMBIENT NOISE RESONATOR

CONCEPTS ILLUSTRATED

1. STANDING WAVES

2. SPEED OF SOUND IN AIR

3. FREQUENCY SPECTRUM OF NOISE

DESCRIPTION OF PACKAGE

1. EIGHT 1 1/2 INCH PVC PIPES OF DIFFERENT LENGTH

2. ONE PADDLE

SUGGESTED ACTIVITIES

1. PLACE YOUR EAR CLOSE TO EACH PIPE AND LISTEN
TO THE TONE. EACH ONE REINFORCES A NOTE OF
THE SCALE TWO OCTAVES BELOW "MIDDLE C".

2. STRIKE THE PIPES WITH THE PADDLE,
TRY TO PLAY A "SONG".

# ANALYSIS OF SOUND

CONCEPTS ILLUSTRATED

1. SOUND WAVES

2. HARMONIC COMBINATION

DESCRIPTION OF PACKAGE

1. FOURIER SYNTHESIZER

2. OSCILLOSCOPE

3. MICROPHONE

4. WIRES

5. SPEAKER

- 1. USE FOURIER SYNTHESIZER TO SHOW FIRST, SECOND, AND THIRD HARMONICS ON THE OSCILLO-SCOPE. LISTEN TO THEM, SHOW HOW FREQUENCY IS INDICATED ON THE OSCILLOSCOPE,
- 2. SHOW MBINATION OF HARMONICS ON THE OSCILLOSCOPL. POINT OUT THAT THE COMBINATIONS ALL HAVE THE FREQUENCY OF THE FUNDAMENTAL, LISTEN TO THE DIFFERENT QUALITY OF EACH COMBINATION.
- 3. LET THE STUDENTS USE THE MICROPHONE TO SEE THE HARMONIC COMBINATIONS FROM THE VOICE.

  (VOWEL SOUNDS SUCH AS O AND E CAN HAVE A RELATIVELY SIMPLE HARMONIC CONTENT)
- 4. HAVE THE STUDENTS BRING MUSICAL INSTRUMENTS TO SCHOOL IN ORDER TO ANALYZE THE SOUND.



## ARTIFICIAL SUNSET

### CONCEPTS ILLUSTRATED

1. SCATTERING

2. WHITE LIGHT COMPOSED OF RED. GREEN, AND BLUE 3. FREQUENCY DEPENDENCE OF SCATTERING

DESCRIPTION OF PACKAGE

1. PLASTIC TANK WITH FLAT SIDES

2. "SUN SLIDE"

3. ONE BOTTLE OF 1 NORMAL HCL 4. ONE BOTTLE OF SODIUM THIOSULFATE SOLUTION 5. ONE GRADUATED CYLINDER

> 6. TWO BEAKERS 7. SLIDE PROJECTOR

SUGGESTED ACTIVITIES

1. SHOW THAT AS SCATTERING INCREASES, A BEAM OF WHITE LIGHT WILL LOSE BLUE AND GREEN, RESULTING IN THE TRANSMISSION OF RED 2. COMPARE THIS TO A SETTING SUN

## BED OF HAILS

CONCEPTS ILLUSTRATED

1. PRESSURE IS INVERSELY RELATED TO THE
AREA OVER WHICH A FORCE IS APPLIED

DESCRIPTION OF PACKAGE

1. BED OF NAILS SUFFICIENT FOR COVERAGE
BY THE AVERAGE BACK OR BUTT

2. SAFETY LID

3. "PRESSURE TESTER"

4. CALIBRATED WEIGHTS

5. SCALES

6. PLATFORM FOR SCALES

- 1. LIE ACROSS OR SIT ON THE BED OF HAILS TO SHOW THAT THE PRESSURE IS NOT SUFFICIENT TO CAUSE PAIN
  - 2. USE THE "PRESSURE TESTER" TO FIND THE AMOUNT OF PRESSURE THAT IS UNCOMFORTABLE
  - 3. MAKE SOME SEMI-QUANTITATIVE ESTIMATES
    OF PRESSURE EXPERIENCED ON THE BED
    OF NAILS (IN UNITS OF NEWTONS PER NAIL)

## CENTER OF MASS

### CONCEPTS ILLUSTRATED

1. BALANCED TORQUES 2. CENTER OF MASS

### **DESCRIPTION OF PACKAGE**

1. "CUT OUT" OF THE STATE OF TEXAS
2. SUPPORT FROM WHICH TO SUSPEND "CUT OUT"
3. PLUMB-BOB

4. SCALE (READING IN NEWTONS)
5. PLANK (2 M LONG BY L5 CM WIDE)
6. PLATFORMS TO SUPPORT EACH END OF PLANK

### SUGGESTED ACTIVITIES

1. SUSPEND THE STATE OF TEXAS BY TWO POINTS (ONE AT A TIME) AND DETERMINE THE GEOGRAPHICAL CENTER OF TEXAS.

2. PLACE A STUDENT ON THE PLANK, SUPPORTED AT HEAD AND FOOT. READ THE FORCE HOLDING UP ONE END. USE METHOD OF BALANCED TORQUES TO FIND THE CENTER OF MASS OF THE STUDENT.



## CURVED SPACE

CONCEPTS ILLUSTRATED

1. EINSTEIN'S MODEL OF GRAVITY

2. SCATTERING BY AN ATTRACTIVE POTENTIAL

A.) RELATION BETWEEN IMPACT PARAMETER AND ORBIT

B.) RELATION BETWEEN KINETIC ENERGY AND ORBIT

DESCRIPTION OF PACKAGE

1. A SECTION (0.3M HEIGHT) OF A LARGE DIAMETER
CYLINDRICAL TUBE (SONOTUBE)

2. ONE PIECE OF 2-WAY STRETCH FABRIC

3. ONE LARGE ELASTIC BAND

4. ONE SHOT-PUT

5. TWO SMALL BALLS

SUGGESTED ACTIVITY

- 1. USE ELASTIC TO HOLD STRETCH FABRIC TIGHTLY OVER TUBE
- 2. ROLL BALL ACROSS THE FLAT SPACE AND WATCH IT FOLLOW A STRAIGHT LINE
  - 3. PLACE SHOT-PUT IN CENTER OF FABRIC
- 4. ROLL BALL ACKOSS "CURVED SPACE" AND WATCH IT FOLLOW A CURVED TRAJECTORY
  - 5. CHANGE THE IMPACT PARAMETER AND INITIAL SPEED TO SEE THE EFFECT ON THE ORBIT

## DIFFRACTION

### CONCEPTS ILLUSTRATED

1. DIFFRACTION 2. COLOR

DESCRIPTION OF PACKAGE

1. SMALL BRIGHT LIGHT IN A LARGE FRAME

2. TRANSFORMER

3. SEVERAL OBJECTS WITH SMALL APERTURES

SUGGESTED ACTIVITIES

1. LET STUDENTS VIEW THE BRIGHT LIGHT THROUGH
THE DIFFERENT OBJECTS
2. HAVE STUDENTS FIND AND BRING OBJECTS FROM
HOME THAT WILL DIFFRACT LIGHT

### GUMBY RIDE

CONCEPTS ILLUSTRATED

1. FRICTION

2. CENTRIPETAL FORCE

DESCRIPTION OF PACKAGE

1. DRILL
2. VARIAC
3. CIRCULAR CAGE
4. FINGER CLAMPS AND SUPPORTS
5. GUMBY

SUGGESTED ACTIVITIES

1. MOUNT CAGE ON DRILL AND SLOWLY INCREASE SPEED WITH VARIAC. PLACE GUMBY ON THE SIDE OF THE CAGE (FEET OFF THE FLOOR) WHEN SPEED IS SUFFICIENT

2. REDUCE SPEED AND WATCH GUMBY FALL 3. REPEAT STEP 1 AND THEN INVERT THE CAGE 4. REPEAT STEP 2

# INTERFERENCE - LIGHT

CONCEPTS ILLUSTRATED

1. INTERFERENCE
2. COLOR

DESCRIPTION OF PACKAGE

1. SODIUM VAPOR LAMP

2. TWO PIECES OF PLATE GLASS

3. LASER

4. DOUBLE SLIT SETS

5. BUBBLE SOLUTION AND BLOWER

- 1. PUT ONE PIECE OF PLATE GLASS ON TOP OF THE OTHER AND ILLUMINATE WITH SODIUM VAPOR LAMP. LOOK FOR INTERFERENCE PATTERNS FORMED BY LIGHT REFLECTING FROM TOP AND BOTTOM OF AIR GAP.

  2. ILLUMINATE ONE DOUBLE SLIT SET WITH THE LASER AND EXAMINE THE INTERFERENCE PATTERN ON A DISTANT SCREEN. COMPARE TO THE PATTERN FORMED BY THE OTHER SLITS WITH A DIFFERENT SEPARATION.
- 3. LOOK AT THE COLORS ON A SOAP BUBBLE. THEY ARE FORMED WHEN DIFFERENT FREQUENCIES OF LIGHT COMBINE CONSTRUCTIVELY AT DIFFERENT THICKNESS OF THE SOAP FILM.

## MUDSLINGER

CONCEPTS ILLUSTRATED

DESCRIPTION OF PACKAGE

1. ONE DOWEL

2. ONE PIECE OF SILLY PUTTY

SUGGESTED ACTIVITIES

1. STICK THE SILLY PUTTY ON THE END OF THE DOWEL.

WHIP THAT END OF THE DOWEL TO A HIGH

VELOCITY. STOP THE DOWEL ABRUPTLY AND WATCH

THE SILLY PUTTY MAINTAIN ITS STATE OF MOTION.

# HEWTONIAN GRAVITY

CONCEPTS ILLUSTRATED

1. NEWTON'S CONCEPT OF GRAVITY AS A FORCE

2. CENTRIPETAL FORCE

3. INERTIA

DESCRIPTION OF PACKAGE

1. CIRCULAR PIECE OF PLATE GLASS
2. TWO AIR PUCKS
3. SUCTION CUP
4. BALLOON BLOWER

SUGGESTED ACTIVITIES

1. GIVE AIR PUCK A PUSH AND WATCH IT GO IN A STRIGHT LINE ACROSS THE PLATE GLASS

2. GIVE THE OTHER AIR PUCK (ATTACHED TO THE STRING ON THE SUCTION CUP) A PUSH AND WATCH IT GO IN A CIRCLE

3. USE THE ANALOGY OF THE SUCTION CUP AS THE

3. USE THE ANALOGY OF THE SUCTION CUP AS THE SUN AND THE AIR PUCK AS THE EARTH TO SHOW NEWTON'S IDEA OF GRAVITY AS A "TUG"
4. NOTE THE IDEA OF INERTIA HERE: THE AIR PUCK WILL CONTINUE TO MOVE IN THE SAME DIRECTION UNLESS ACTED ON BY A FORCE

## NON-INERTIAL REFERENCE FRAME

## CONCEPTS ILLUSTRATED

1. LAW OF INERTIA

2. CENTRIFUGAL FORCE IS A FICTITIOUS FORCE

### DESCRIPTION OF PACKAGE

- 1. ROTATING PLATFORM WITH PLATE GLASS TOP
- 2. MINIATURE GUMBY TO RIDE ON THE PLATFORM 3. AIR PUCK

- 1. ROTATE THE PLATFORM WITH GUMBY ATTACHED TO IT. WHEN GUMBY IS DIAMETRICALLY OPPOSITE YOU. PUSH AIR PUCK TOWARD HIM.
- 2. ASK THE CLASS TO DESCRIBE WHAT HAPPENS FROM GUMBY'S POINT OF VIEW.
- 3. REPEAT STEP #1, BUT HAVE A STUDENT STANDING ON THE FLOOR, DIAMETRICALLY OPPOSITE YOU, CATCH THE AIR PUCK. ASK STUDENTS TO DESCRIBE WHAT HAPPENS FROM HIS OR HER POINT OF VIEW.

# POLARIZED LIGHT

CONCEPTS ILLUSTRATED

1. POLARIZATION BY SELECTIVE ABSORPTION

2. OPTICAL ACTIVITY

3. THREE-DIMENSIONAL VIEWING FROM A SLAT GUEST

3. THREE-DIMENSIONAL VIEWING FROM A FLAT SURFACE
4. COLOR

### DESCRIPTION OF PACKAGE

- 1. LARGE POLAROID OVERLAY FOR LOWER STAGE OF OVERHEAD PROJECTOR
- 2. SMALL POLAROID IN FRAME FOR TOP OF OVER-HEAD PROJECTOR
  - 3. 3-D POLAROID GLASSES
  - 4. POLAROID SUN GLASSES
    5. CELLOPHANE
  - 6. PLEXIGLASS "STRESS TESTER"

- 1. DEMONSTRATE POLARIZATION BY SELECTIVE ABSORP-TION BY USING CROSSED POLARIZERS ON OVERHEAD PROJECTOR
  - 2, SHOW DIRECTIONS OF POLARIZATION OF LENSES
    OF 3-D GLASSES
  - 3. SHOW DIRECTION OF POLARIZATION OF POLAROID SUN GLASSES
- 4. USE CELLOPHANE AND PLEXIGLASS WITH CROSSED POLARIZERS TO DEMONSTRATE THE ROTATION OF THE PLANE OF POLARIZATION BY OPTICALLY ACTIVE MATERIALS

## POLARIZATION - SCATTERING

#### **CONCEPTS ILLUSTRATED**

1. SCATTERING

2. POLARIZATION

#### DESCRIPTION OF PACKAGE

1. LASER

2. WATER TANK

3. POWDERED CREAMER

4. PIECE OF POLAROID

- 1. SHOW HOW ADDING A SMALL AMOUNT OF POWDER INCREASES THE SCATTERING
- 2. VIEW THE SCATTERED LIGHT THROUGH A PIECE OF POLAROID. ROTATE THE POLAROID.
- 3. LOOK AT POLARIZATION OF LIGHT SCATTERED AT RIGHT ANGLES OPPOSED TO LIGHT SCATTERED AT OTHER ANGLES.
  - 4. LET STUDENTS GO OUTSIDE AND VIEW THE SKY THROUGH THE POLAROID.

# ROTATING PLATFORM

CONCEPTS ILLUSTRATED

1. CONSERVATION OF ROTATIONAL (ANGULAR) MOMENTUM

2. VECTOR NATURE OF ROTATIONAL MOMENTUM

3. ROTATIONAL INERTIA

DESCRIPTION OF PACKAGE

1. ROTATING PLATFORM

2. BICYCLE WHEEL WITH HANDLE

3. WEIGHTS

SUGGESTED ACTIVITIES

1. STAND ON THE ROTATING PLATFORM, SPINNING WITH
ARMS OUTSTRETCHED. BRING YOUR ARMS DOWN

TO YOUR SIDE

2. ACCEPT BICYCLE WHEEL (HANDLE VERTICAL) WHILE STANDING ON THE PLATFORM. ROTATE HANDLE 180 DEGREES

3. HAVE SOMEONE TRY TO TURN THE PLATFORM WHILE YOU STAND ON IT, HOLDING WEIGHTS DOWN AT YOUR SIDES; NOW TRY IT WITH ARMS OUTSTRETCHED (STILL HOLDING THE WEIGHTS)

## SCATTERING

1. SCATTERING 2. COLOR

# 1. SLIDE PROJECTOR

2. "BEAM SLIDE" 3. AQUARIUM 4. POWDERED COFFEE CREAMER

5. WHITE CARDBOARD

SUGGESTED ACTIVITIES

1. OBSERVE BEAM FROM THE SIDE WITHOUT AND WITH SCATTERING PARTICLES IN THE WATER. (NOTE THE COLOR OF THE SCATTERED LIGHT.)

2. OBSERVE THE TRANSMITTED BEAM BY HOLDING A PIECE OF WHITE CARDBOARD IN FRONT OF IT. WHY IS IT YELLOW?

# SINGING SEWER PIPES

(HOT AIR RESONATORS)

CONCEPTS ILLUSTRATED

1. SOUND

2. STANDING WAVES

3. BEATS

DESCRIPTION OF PACKAGE

1. THREE PVC PIPES (10 CM DIAMETER) OF LENGTHS:

113 CM, 120 CM, 150 CM

2. TWO MEKER BURNERS

3. GAS HOSES

4. T-CONNECTOR

5. PROPANE BOTTLE ADAPTED TO FIT GAS HOSE

6. INSULATED GLOVES

- 1. SLOWLY LOWER EACH PIPE OVER A BURNER UNTIL THE FLAME IS ABOUT 5 CM INTO THE PIPE. LISTEN TO THE TONES PRODUCED. RELATE FREQUENCY TO LENGTH OF PIPE.
- 2. USING TWO BURNERS, SOUND THE 113 CM PIPE AND THE 120 CM PIPE SIMULTANEOUSLY. THEIR FREQUENCIES ARE CLOSE ENOUGH TOGETHER TO PRODUCE BEATS.

## SPECTRA

### CONCEPTS ILLUSTRATED

1. COLOR

2. EMISSION LINES

3. DIFFRACTION

### DESCRIPTION OF PACKAGE

- 1. HG "YARD LIGHT" (IN HOUSE)
- 2. NA "YARD LIGHT" (IN HOUSE)
- 3. LOW PRESSURE NA LAMP (IN HOUSE)
- 4. TUNGSTEN FILAMENT BULB (IN HOUSE)
- 5. THIRTY CARDBOARD MOUNTED DIFFRACTION GRATINGS
- 6. ONE "HIGHER QUALITY" DIFFRACTION GRATING
  7. BICYCLE FENDER SPECTROMETER
  8. MULTI-COLORED OBJECTS

- 1. EXAMINE THE COLORED OBJECTS UNDER EACH TYPE OF ILLUMINATION.
  - 2. LOOK AT EACH SOURCE THROUGH A DIFFRACTION GRATING.
- 3. USE THE SPECTROMETER TO MEASURE THE WAVELENGTH OF SOME OF THE BRIGHTEST LINES IN THE VAPOR SOURCE.

# STANDING WAVES ON ROPE

1. TRANSVERSE WAVES
2. STANDING WAVES

DESCRIPTION OF PACKAGE

1. SABRE SAW
2. STAND AND CLAMPS FOR SABRE SAW
3. WEIGHTS FOR TENSION
4. VARIAC
5. STROBE LIGHT

- 1. SET UP A STANDING WAVE ON THE ROPE BY DRIVING THE SABRE SAW AT AN APPROPRIATE FREQUENCY
- 2. INVESTIGATE THE STANDING WAVE UNDER THE STROBE LIGHT IN ORDER TO SEE THE ACTUAL DISPLACEMENT OF EACH PART OF THE JUMP ROPE AS A FUNCTION OF TIME
- 3. USE THE VARIAC TO CHANGE THE FREQUENCY, THUS SHOWING THAT ONLY CERTAIN FREQUENCIES WILL RESULT IN A STANDING WAVE
  - 4. VARY THE TENSION IN THE ROPE

# TABLECLOTH TRICK

CONCEPTS ILLUSTRATED

1. INERTIA (MAYBE)

2. FRACTION (STATIC AND SLIDING)

3. ACCELERATION PROPORTIONAL TO FORCE

4. FINAL VELOCITY DEPENDS ON TIME OF ACCELERATION

DESCRIPTION OF PACKAGE

1. ONE TABLECLOTH (FLOWERED)

2. ONE DINNER PLATE

3. ONE CUP AND SAUCER

4. ONE GLASS

SUGGESTED ACTIVITIES

1. PULL THE TABLECLOTH OUT FROM UNDER THE
SETTING WITHOUT DISTURBING THE DISHES

# VIBRATING MEMBRAHE

CONCEPTS ILLUSTRATED

1. STANDING WAVES IN TWO DIMENSIONS

DESCRIPTION OF PACKAGE

1. SPEAKER ENCLOSED IN A CANNISTER

2. THIN RUBBER MEMBRANE OVER CANNISTER

3. VARIABLE FREQUENCY SINE WAVE GENERATOR

4. AMPLIFIER

5. STROBE LIGHT

- 1. USE AMPLIFIED SINE WAVE THROUGH SPEAKER TO DRIVE THE RUBBER MEMBRANE IN FORCED OSCILLATIONS.
- 2. VARY THE FREQUENCY UNTIL THE MEMBRANE ACHIEVES A LARGE RESPONSE. AT THIS POINT, A STANDING WAVE HAS BEEN SET UP.
- 3. INVESTIGATE THE BEHAVIOR OF ALL PARTS OF THE MEMBRANE UNDER A STROBE LIGHT. TRY TO IDENTIFY NODAL LINES. IN SOME MODES THEY WILL BE CIRCLES: IN OTHER MODES THEY WILL BE STRAIGHT LINES.
  - 4. FIND AS MANY DIFFERENT STANDING WAVE MODES
    AS YOU CAN.

## WEIGHT IN NEWTONS

### CONCEPTS ILLUSTRATED

- 1. S.I. UNIT OF FORCE
- 2. WEIGHT IS A FORCE

### DESCRIPTION OF PACKAGE

- 1. BATHROOM SCALE READING IN NEWTONS
  - 2. A 1N WEIGHT
  - 3. A 10N WEIGHT
  - 4. A BOX FILLED WITH WEIGHTS

#### SUGGESTED ACTIVITIES

- 1. ASK WHAT A POUND IS
- 2. PASS AROUND THE 1N AND 10N WEIGHTS
- 3. ASK EACH STUDENT TO ESTIMATE THEIR WEIGHT IN NEWTONS
  - 4. USE SCALES TO MEASURE WEIGHT IN NEWTONS
    - 5. HAVE STUDENTS LIFT THE BOX OF WEIGHTS
      - A.) ASK SOME STUDENT FOR ESTIMATE
        - IN POUNDS
- B.) ASK OTHER STUDENTS FOR ESTIMATE IN NEWTONS
  - C.) CHECK THE ANSWERS

NOTE: THESE SCALES ARE NOT ACCURATE FOR SMALL WEIGHTS (LESS THAN 100N)